

Conference Paper

The Importance of L.S. Vygotsky's and A.R. Luria's Ideas in the Study of 'Twice Exceptional' Children

Yulia Babaeva, Aleksey Korneev, and Anatoly Krichevets

Lomonosov Moscow State University, Moscow, Russia

Abstract

The article highlights the importance of 'twice exceptionality' studies and the significance of L.S. Vygotsky and A.R. Luria's ideas for this research. Twice exceptional children combine the signs of giftedness with one or several mental disabilities, specific learning difficulties, etc. In our research, we analyzed the development of writing skills in three groups of school children with different variants of mental functions development, distinguished on the basis of neuropsychological characteristics. The use of the original method of recording movements while writing, combined with a neuropsychological assessment of children allowed revealing the dependence of writing parameters and their dynamics on the strength and weakness of the components involved in the functional system of writing. According to the results obtained, each group has its own pattern of the following parameters: time, writing quality and errors, explained by the primary weakness in the child's functional system of writing and compensatory restructuring. A comparative analysis of analytical and holistic strategies use in reading was also conducted.

Keywords: 'twice exceptional children', mental functions development desynchrony, neuropsychological analysis, difficulties and specific errors in writing.

Corresponding Author:
Yulia Babaeva
julybabaeva@gmail.com

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1. Introduction

According to L.S. Vygotsky, typical and atypical in mental development, should be studied in a single scientific paradigm, which leads to the "dialectical doctrine of plus and minus-giftedness". Analysis of various deviations will deepen the understanding of developmental processes. In recent years, the term "twice exceptional children" has been increasingly used in foreign and Russian psycho-pedagogical literature. [1, 2] It implies a combination of giftedness signs with various mental disabilities, severe learning difficulties, etc. "Exceptionality" is understood as the presence of significant

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deviations from the norm (both positive and negative) in one or several spheres of psychological development. To help these children, it's necessary to develop special diagnostic methods and correctional programs, as well as train teachers to work with them. But first of all, it is necessary to study the psychological nature of this phenomenon. Our research is based on L.S. Vygotsky's and A.R. Luria's ideas that the primary weakness is followed by secondary changes and compensatory restructuring (both successful and false). The features of their probability self-organization are determined by the interaction of strong and weak components of higher mental functions (hereinafter referred to as HMF), environment and child activity. Therefore, the effect of the primary weakness shouldn't be understood under the principle of a rigid causal relationship.

Teachers, parents and researchers report an increasing number of children with learning disabilities. Most of them are characterized by a partial lag in the development of the HMF. One of the ways of helping these children is building learning technologies which consider different variants of child's unpreparedness for learning process. Analysis of these variants is an important aim of children neuropsychology [3].

In elementary school many gifted children experience difficulties in mastering writing and reading. It prevents teachers from noticing their giftedness and adversely affects their abilities development. Therefore, making effective diagnostic techniques that allow to analyze various aspects of difficulties arising during the acquisition of writing and reading becomes an important task. This approach will contribute to the creation of highly individualized correctional programs.

The study of the difficulties of mastering writing started by A.R. Luria is actively continued by modern neuropsychologists. The first direction of research is connected with the logopedic tradition in studying dysgraphia. In these works, specific difficulties of writing, their relationship to children's neuropsychological status are analyzed, mechanisms and typical errors are identified [4].

The second research direction is characterized by combining the neuropsychological approach with experimental study of writing parameters [5, 6]. The use of a computer graphic tablet allowed us to record several dynamic parameters of writing (total time, pause time, time of pure writing) and its visual-spatial characteristics (writing quality). In the work by T.V. Akhutina et al. [7], devoted to the study of the first-graders' handwriting, these parameters were compared with children's neuropsychological assessment data. Significant correlations between the integral index of writing skills development and such indicators as: the state of mental functions' summary

index, indicators of visual, visual-spatial functions, activity regulation functions, as well as programming and control were revealed.

Our work, developing the second direction of research, also approaches the first direction through the analysis of errors. The research considers two main problems. The first is to study the changes in writing parameters in cognitively complex and simple tasks, depending on the characteristics of the children's HMF. The second considers the comparative analysis of writing in children with different neuropsychological profiles reflecting the strength or weakness of the individual components of the HMF.

1.1. Hypotheses

1. Each group of children identified on the basis of common neuropsychological characteristics corresponds to a specific pattern of time, writing quality and error parameters, which is explained by primary weakness in the functional system of writing.
2. The patterns of writing features for different neuropsychological groups change alongside with development of writing.
3. There is a relationship between the characteristics of writing and reading, due to the primary weakness in the functional systems of writing and reading in the child.

2. Methods

2.1. Subjects

In the longitudinal study of writing skills development, 27 students took part in 2nd and then 3rd grade. Among them were children who successfully mastered the school curriculum, and those who, according to the assessment of teachers and psychologists, had learning difficulties.

To assess the state of writing skills depending on the cognitive complexity of the task an original technique involving two tasks was used. More complex task was to construct a text using words presented in the infinitive form. The subjects were given a card with words grouped for future sentences, then asked to compose and write down the sentences. This required the construction of a sentence's semantic program, its grammatical structure, changes in the forms of words and their order in accordance with the structure of the sentence, and the retention of the compiled text in memory.

In the second task, it was suggested to copy the text composed by the experimenter from the same words. It implied the retention of stimulus in short-term verbal memory (auditory, motor or visual and visual-spatial).

The graphic Wacom Intuous3 A4 was used with an ink pen. Subjects wrote on a standard notebook. Our original program allowed to record their movements. Registered: the total time of writing, the time of actual writing, the time of pauses (lifting of hand during writing), the quality of writing (spatial characteristics measured as the stability of the line edges), the number of errors of different types.

Errors associated with construction of the text (syntactic, word order violations, pragmatic-semantic, leading to writing of meaningless sentences), nonspecific (spelling, punctuation) and specific ones were classified. The latter include errors specific for different types of dysgraphia: regulatory (perseveration, anticipation, contamination of different elements of the text, omissions of letters and words); errors indicating the edges of sentences; acoustical-articulatory errors (substitutions and omissions of consonants); visual-spatial errors, omissions and substitutions of vowels. [4]

To study the state of reading, an original method was used to evaluate the use of analytical (left hemisphere) and holistic (right hemisphere) reading strategies. [8] Successful reading of words with regular phonetic spelling, and irregular traditional one is common for the holistic strategy, because these words are fully recognized. Analytical strategy implies more successful reading of regular words (with regular sound-letter correspondences) compared with irregular words.

The reading task included 4 groups of words (15 words in each): frequent with regular spelling, frequent with irregular spelling; non-frequent with regular spelling and non-frequent irregular. Subjects were asked to read the words. Their reading was tape-recorded and then analyzed. The total productivity of reading each series, mistakes (letter-by-word, post-syllabic reading of words, skipping or replacing sound, stress errors, etc.) were counted.

2.2. Neuropsychological assessment

To assess the status of various components of the HMF, the "Neuropsychological assessment method for children aged 5-9 years" was used. [9].

To distinguish subgroups that differ in strength and weakness of different components of the HMF, the three integral neuropsychological indices were compared. The first index characterizes the state of the executive functions and serial organization

of movements (III functional unit of brain according to Luria); the second – reflects the state of functions for processing auditory and kinesthetic information (II functional unit, left hemisphere); the third reflects the state of various functions realizing the holistic strategy (II and III functional units, right hemisphere).

The indices were set by penalty points, the higher value corresponds to the worst state of functions, the average sample score was 0. Children were divided into three groups based on predominant weakness in one of the three indices. Each group included children varying in performing neuropsychological tests, but the average total ranks made up of all three neuropsychological indices were approximately equal (Table 1).

TABLE 1: Neuropsychological indices of the three groups.

Indices	Group1	Group2	Group3
Index of the III unit functions	1.18	0.05	0.18
Index of the II unit functions of the left hemisphere	−0.29	1.08	−0.24
Index of the right hemisphere functions	0.15	0.06	1.25
Total index	1.04	1.19	1.2
The average total rank for the whole sample	15.8	16.8	15.6

The first group included children with relative weakness of the III unit functions; the second – with the difficulty of processing auditory and kinesthetic information; the third – with the weakness of the right hemispheric functions. The average school grade in the first group is 3.65 points, in the second group – 3.88, in the third – 4.45, which indicates heterogeneous influence of the strengths and weaknesses of HMF various components on the successful learning.

3. Results and Discussion

Differences in the majority of measured indicators were revealed.

3.1. Temporal characteristics of writing

Total time for both tasks in the 2nd grade was the lowest in the first group (Table 2). In the 3rd grade, the same indicator significantly, but unevenly decreased in all groups. In the first group it was 26sec. and 31sec., in the second – 61sec. and 44sec., in the third – 114sec. and 43sec. The reason for the minimal reduction of time in both assignments for children from the first group may be a slower automatization of writing due to

relative weakness of movement serial organization. This hypothesis is confirmed by the results of analysis of pure writing time indicator. The difference of this group from the others is statistically significant in the Student's t-criterion both for copying and for compiling ($p = 0.048$ and $p = 0.084$, respectively).

TABLE 2: The values of the main measured parameters in two types of writing tasks (compilation and copying) in three groups.

Parameters	Group1 (relative weakness of the left hemisphere's III unit)		Group2 (relative weakness of the left hemisphere's II unit)		Group3 (relative weakness of the right hemisphere)	
	2nd grade	3rd grade	2nd grade	3rd grade	2nd grade	3rd grade
Total time at compilation	216	190	256	195	268	154
Total time at copying	156	125	166	122	163	120
Quality of writing at compilation	0.98	1.58	1.23	1.11	1.65	1.09
Quality of writing at copying	1.13	1.19	1.07	0.92	1.03	1.18
Average number of errors at compilation	6.4	5.0	5.5	4.0	6.4	4.2
Average number of errors at copying	1.3	1.9	2.5	1.7	2.3	1.9

A distinct reduction of time indices in the assignment for the construction of sentences in Group2 and Group3 is probably relates to the improvement and acceleration of the cognitive task. In children from the first group (with a relative lag in the executive functions), less progress in compilation of sentences is confirmed by data on the speech characteristics of these children [10].

3.2. The quality of writing

In the second class, there are practically no intergroup differences in the quality of writing while copying (Table 2). In the assignment for the compilation of sentences, the third group showed the worst results, which is explained by the visual and spatial difficulties experienced by its children. In the second group, the worst quality is explained by the insufficiently developed motor skills inherent in children with the weakness of kinesthetic information processing. However, in the third class, an inverse picture was found (Table 2).

The indicators of the first group decreased by 0.60, and the second and third – improved by 0.12 and 0.56 respectively. When copying, there are similar, but less explicit changes. In the third grade the quality of writing varies in different ways. We can assume that children from Group1 (with programming and control difficulties), don't cope with increasing requirements for writing speed and sacrifice quality trying to accelerate. Difficulties of arranging functional brain ensembles specific for children with weak programming and control functions are added (this is indicated by a greater impairment in a cognitively complex task requiring complex interaction of components). The impairment of writing quality among some third graders is noticed by many experienced teachers, but the nature of this phenomenon is still not clear.

The third-grade students from Group1 showed the greatest time of tasks completion and the time of a pure writing, the worst quality of writing. It indicates a lack of automatization and high energy intensity of writing skills in these children. Therefore, they make many mistakes.

3.3. Errors

The maximum number of errors was made by children with weak programming and control functions, weak serial organization of movements (Group1 with the average 16.6, Group2 and Group3 – 14.3 and 15.1 respectively). Analysis of different types of errors (Table 3) showed that Group1 made the greatest number of errors in construction of sentences (average – 5.3), Group2 – 3, Group3 – 4. These results are confirmed by the neuropsychological data considering the weakness of the sentences' syntactic organization and their semantic programming in children with a lag in the development of the functions of the third unit, and the insufficient development of an analytical strategy [10].

In the first group, there are also more regulatory errors and errors in the delimits of sentences. Both types of errors are typical for children with poor programming and control [11].

According to the results of the calculation of another type of specific errors (substitution and omission of consonants), their maximum number was in children from Group2 – an average of 1.7 (in the first group – 0.7, in the third – 0.4). Analysis of the third type of specific errors (visual and spatial errors and substitution or omission of vowels) showed that the greatest numbers of visual and spatial errors are made by children from Group3 (2.6 on average, compared to 1.2 in the first and 1.3 in the second group) that confirms our assumption. By the number of substitutions and omissions of

TABLE 3: Types and quantity of errors in three groups.

Error Type	Group1 (relative weakness of the left hemisphere's III unit)		Group2 (relative weakness of the left hemisphere's II unit)		Group3 (relative weakness of the right hemisphere)	
	2nd grade	3rd grade	2nd grade	3rd grade	2nd grade	3rd grade
Errors in sentences compilation	4.1	1.2	1.8	1.2	2.0	2.0
Specific errors in compilation	1.3	2.7	2.1	1.0	1.2	2.6
Non-specific errors in compilation	1.0	1.4	1.4	1.8	2.2	0.9
Specific errors in copying	1.3	1.7	1.7	1.1	2.9	1.1
Non-specific errors in copying	0	0.2	0.8	0	0.3	0.3

vowels, the third group was in second place (on average 0.8 at 1.2 and 0.4 in the first and second groups). It should be noted that substitutions and omissions of the vowels and consonants are distinctive for children with the weakness of the holistic strategy. In Group3, the number of errors per vowel is twice as large as that of consonants. The inverse relationship was noted in children of the second group with a weakness of auditory and kinesthetic information processing, which corresponds to the data we obtained earlier [7].

Analysis of nonspecific (spelling and punctuation) errors showed that their distribution in subgroups is different. If the maximum number of spelling errors was observed in Group3 (2.1 on average versus 1.8 and 1.6 in the first and second groups), then punctuation errors are greater in Group2 (2.4 on average compared to 0.8 and 1.7 in Group1 and Group3). It can be assumed that in children with a weakness of the holistic strategy of processing visual and visual-spatial information (Group3), it is difficult to form 'spelling vigilance', remembering complex images of spelling words, which increases spelling errors. In children from Group1, the increase of spelling errors is due to difficulties in distributing attention between the technical side of the writing and the need to comply with spelling rules. The main part of punctuation errors is associated with the omission of commas in a sentence with three homogeneous terms. The retention in the memory of these words exceeds the possibilities of auditory memory of children from Group2. Therefore, they can skip one or two words from homogeneous parts of the sentence, forget to put commas. The reduction of auditory memory is a typical manifestation of difficulties in the processing of auditory information, specific for children from Group2.

Our research confirmed the hypothesis that each group, distinguished on the basis of neuropsychological characteristics, has its specific pattern of temporal characteristics, quality of writing and errors. These patterns are explained by the primary weakness in the functional writing system. However, we must remember that within these patterns, which set the general direction of writing skill development, an important role plays individual variability associated with the specifics of the student's compensatory strategies. The results obtained can be used to develop health-saving technologies for teaching writing.

The other aim was to analyze the use of analytical and holistic strategies in reading. The holistic strategy is characterized by equally successful reading of regular and irregular words, since they are recognized as a whole. Analytic strategy is characterized by a more successful reading of regular words, compared with irregular ones. We were interested in the changes in the nature of reading errors in groups with different neuropsychological indicators and different success in learning, as well as the correlation of errors in reading and writing.

The average number of errors in reading as a whole for the sample was 14.3. Comparison of the total number of reading errors in two groups of subjects differing in learning success found that in the group of children experiencing learning difficulties, the average number of errors was 22.9, which was significantly higher ($p = 0.021$ in Student's t-test) than for the other children (5.7).

To demonstrate the advantages of one of the reading strategies, we consider two cases. In the subject V. (from the second group, which included children with relative weakness of the analytical strategy), the index of processing auditory and kinesthetic information – 23, a similar indicator of the state of visual-spatial functions – 3. In the subject M. (the third group, including children with weakness of holistic strategy), on the contrary, the first indicator is 3, the second – 17. Thus, in both cases bright dissociation in the development of analytical and holistic strategies is revealed. An analysis of their reading showed that V. successfully read frequency words (the productivity was 24.5, the non-frequency reading was 12.5). The factor of regularity has practically no effect on the success of reading (the productivity for regular words was 16.5, for irregular words – 20.5). It's probable that when reading she uses a predominantly holistic strategy (due to the weakness of the analytical strategy recorded in the neuropsychological assessment). For M. both factors – the regularity and frequency of words equally influenced the success of reading. She read more successfully regular and frequency words (in both cases productivity was 29 words) than irregular and low-frequency (in both cases productivity was 24 words). We can assume that M's active

use of analytical reading strategies is due to the weakness of the holistic strategy. Both subjects made writing mistakes, typical for children of the second and third groups. This allows us to say that they used both in writing and reading the most developed strategy.

With less pronounced cases of dissociation in the development of two types of information processing strategies, the picture of their use in reading is less clear. To refine the findings, additional studies are needed with an increase in the sample of subjects.

4. Conclusions

The obtained data confirmed the hypothesis that each group distinguished on the basis of neuropsychological characteristics has its specific pattern of time, writing quality and errors. The features of these patterns are explained by the primary weakness in the functional writing system. Inside the patterns that define the general direction of writing skill development, individual variability plays an important role, connected with the specifics of the student's compensatory strategies. The results of the study demonstrated the adequacy of the developed and verified experimental methods aimed at detecting the key aspects of writing and reading. New empirical data have been obtained, their use will contribute to the creation of highly individualized correctional programs for children with difficulties in mastering writing and reading, including children with "twice exceptionality".

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